



Department of Environmental Quality

## Oregon Low Carbon Fuel Standard (HB 2186)

### Indirect Land Use Changes & Other Indirect Effects (Information Only)

Cory-Ann Wind  
Oregon DEQ



Department of Environmental Quality

### Purpose

- Preview the concept of indirect effects
- Delineate which indirect effects are covered by the standard
- Provide an overview of issues related to indirect land use changes
- Consider how addressing indirect effects could impact the Oregon LCFS program



## Timeline

**August 10<sup>th</sup> – TIAx presents Compliance Scenario results (compare w/ & w/o ILUC) which will provide the outer bounds of the effect of including an ILUC**

**Oct 7<sup>th</sup> - TIAx presents Comparative Analysis of Indirect Land Use Changes in various programs**

**Oct 14<sup>th</sup> (if needed) – final discussion and input on what number, if any, to be included in the draft rule and how Oregon should implement it**



## Questions for the Advisory Committee

- **Should Oregon include both direct and indirect effects of producing fuels in calculating carbon intensities?**
- **What approach (California, EPA, Purdue, or British Columbia) should we use?**



### Why is this Important?

- GHG emissions from indirect land use changes can account for up to twice the amount as that of the direct effects.

	Direct (gCO <sub>2</sub> e/MJ)	CARB ILUC (gCO <sub>2</sub> e/MJ)	Total (gCO <sub>2</sub> e/MJ)
Midwest corn ethanol	64.82	30	105.1
Brazilian sugar cane ethanol	26.44	46	73.4

	Carbon Intensity (gCO <sub>2</sub> e/MJ)
Gasoline	92.34

This can significantly alter the way the LCFS will be complied with.



### HB 2186

Section 6(2)(b)(B): The commission may adopt...standards for greenhouse gas emissions attributable to the fuels throughout their lifecycles, including but not limited to emissions from the production, storage, transportation and combustion of the fuels and from changes in land use associated with the fuels;"



## What is Indirect Land Use Change?

- Low Carbon Fuel and Renewable Fuel Standards both promote the use of biofuels in the future.
- A large increase in the amount of biofuels produced could lead to non-agricultural lands being converted to cropland.
- Carbon is released from the loss (burned or decomposing) of cover vegetation and disruption of soils following conversion.
- Large emissions of GHG occur initially from above ground materials and smaller emissions continue over time from below ground materials.



## Quantifying Indirect Land Use Changes CARB & Purdue Method

- Global Trade Analysis Project (GTAP) is a general equilibrium model developed and supported by researchers at Purdue University. GTAP assigns a value to the impact which can be added to the direct emissions calculated in GREET.
- CARB used GTAP to develop their numbers.
- Purdue recently updated this model for MW corn ethanol.



## Quantifying Indirect Land Use Changes EPA Method

- Forestry and Agricultural Sector Optimization Model (FASOM) is a partial equilibrium economic model developed by Texas A&M University.
- The DAYCENT model simulates plant-soil systems and is capable of simulating detailed daily soil water and temperature dynamics and trace gas fluxes (CH<sub>4</sub>, N<sub>2</sub>O, NO<sub>x</sub> and N<sub>2</sub>).
- The CENTURY model is a generalized plant-soil ecosystem model that simulates plant production, soil carbon dynamics, soil nutrient dynamics, and soil water and temperature.
- FAPRI-CARD is a worldwide agricultural sector economic model that was run by the Center for Agricultural and Rural Development (CARD) at Iowa State University



## Significant Issues Affecting Indirect Land Use Changes

- **Modeling of land use change data**
  - Economic modeling of these changes are still in its infancy
- **Accuracy of land cover estimates**
  - Better inventory of current situation
  - Co-product credits
  - Future crop yields
  - Inclusion of abandon crop lands



## Comparison of ILUC Values

Pathway	Direct	Indirect Land Use Changes		
	OR GREET g CO <sub>2</sub> e/MJ	CARB g CO <sub>2</sub> e/MJ	EPA g CO <sub>2</sub> e/MJ	Purdue g CO <sub>2</sub> e/MJ
Ethanol, MW Corn, MW Production	64.82	30.00	26.00	14.00
Ethanol, MW Corn, NW Production	56.99	30.00	26.00	
Ethanol, Farmed Trees	15.54	5.00*	3.00	
Ethanol, Brazilian Sugarcane	26.44	46.00	5.00	**
Biodiesel, MW Soybeans	19.99	62.00	32.00	**

\* CARB used the switchgrass value (18) for farmed tree ethanol. JP changed this to 5. Because the yield/acre for poplar is much higher than switchgrass, their CI is adjusted accordingly.

\*\* Purdue also estimated new ILUCs for Brazilian sugarcane ethanol and Midwest soybean biodiesel but have yet to report out on the results.



## Defining “Indirect Effects”

1. **Direct effects:** All significant effects within the primary production chain or life cycle (well to wheel)
2. **Co-product effects:** Significant effects caused by co-products from the production chain
3. **Other market-mediated effects:** Significant effects caused by changes in economic markets, e.g. Indirect Land Use Changes.

**Recommendation to CARB from the Expert Workgroup Indirect Effects Sub-workgroup:** Define indirect effects as ‘market-mediated effects other than co-product effects’

Effects that are not calculated by GREET.



## CARB Updates – 7/15/2010 Indirect Effects Sub-workgroup

	Goal	Deadline
Task 1	Establish Criteria for Defining Indirect Effects of Other Fuels	May 2010

<http://www.arb.ca.gov/fuels/lcfs/workgroups/ewg/expertworkgroup.htm>



## Criteria for Evaluation

- Potential level of impact
- Reasonably quantifiable
- Low, Medium, High



**CARB Updates – 7/15/2010  
Indirect Effects Sub-workgroup**

	Goal	Deadline
Task 2	Develop a List of Indirect Effects to be Assessed	June 2010



**Potential Indirect Effects**

<u>Documentation</u> <u>Goal</u>	<u>Potential Indirect Effects</u>	<u>Potential Level of Impact</u>	<u>Responsible Organization</u>
GHG emissions	GHG accounting: All Products use 100% of energy in CA gasoline yet merchant H2 exports are excluded from the GHGET model.	MED	MED
	How are petroleum coke and other petroleum co-products accounting for?	LO	HI
	With respect to weight reduction strategies, what is the GHG Impact of replacing steel with aluminum in vehicles beyond the direct fuel economy benefits (Gleason)?	MED	HI
	Issues raised in the report prepared by Life Cycle Associates for the New Paris Al Issues Environmental carbon impacts of sales	MED	MED
		HI	MED/LO

<u>Documentation</u> <u>Goal</u>	<u>Potential Indirect Effects</u>	<u>Potential Level of Impact</u>	<u>Responsible Organization</u>
Crude oil	The LCPS assumes carbon intensity is constant for the 2000 year. What happens to the carbon intensity in the future as the mix of crude changes in California? Will need to track progress of the Crude Oil Screening Workgroup.	MED	MED
	Some issues discussed by the Crude Screening Workgroup (from Jacobs presentation):		
	• Primary vs. secondary vs. tertiary extraction methods	MED	HI
	• Weathering	LO	HI
	• Reservoir characteristics (depth, pressure, water ratio, gas/oil ratio)	LO/MED	MED
	• Treatment of produced water and gas	LO	HI
	• Change in reservoir properties over time	MED/HI	HI
	Oil sand's water	HI	MED
	Slurries, emulsions, and other non-volatile crude oil sources.	HI	MED
	Environmental carbon impacts of sales		



Potential Indirect Effects (cont.)

Transmission Path	Potential Indirect Effects	Potential Level of Impact	Reasonable Quantification?
Battery Electric Vehicles and Plug-In Hybrids	Battery materials production, transport, battery manufacturer's transport, and end-of-life recycling requirements excluded from LCFS	MED	LO
	Life-cycle mining	MED	MED
Electricity	Battery production life cycle issues (listed above)	MED	LO
	BP/PC's Post-combustion CO <sub>2</sub> "sequestration" is being used for EOR; this "co-product" should be "credited" as a debit.	MED	LO
	Short-, medium-, and long-term energy sources and availability? Coal? Nuclear? Top sources?	MED/Hi	MED
Transmission Path	Potential Indirect Effects	Potential Level of Impact	Reasonable Quantification?
Natural Gas	Conventional gas is being systematically replaced with shale gas, tight gas, and CBM. Horizontal drilling, high pressure multi-stage fracking of marine shale involve higher energy use (e.g., production and use of equipment, and in injections)	Hi	MED/LO
Hydrogen	Energy for processing associated w/ SMR (2001.9 kg/3 m <sup>3</sup> H <sub>2</sub> g/s) required for parity between vint. 1 & 2 mill times.	LO	MED
	Methanol production (for methanol reformer PBM) and indirect effects of increased production	MED	LO
	PBM life-cycle and rare earth metal indirect effects	MED	LO



Potential Indirect Effects (cont.)

Transmission Path	Potential Indirect Effects	Potential Level of Impact	Reasonable Quantification?
Straw and other effects	What are the indirect effects not currently captured in ABM's analysis?		
	Duckweed has been the following as potential indirect effects:		
	• Changes in wildlife and	Hi	Hi
	• Changes in albedo	LO	LO
	• Changes in evapotranspiration	LO	MED
	• Changes in riparianity as a result of irrigation	MED/LO	LO
	• Agricultural dust	MED	LO
Impact of increased nitrogen content of DSD on ASD from manure handling operations	LO/Hi?	LO	



## CARB Updates – 7/15/2010 Indirect Effects Sub-workgroup

	Goal	Deadline
Task 3	Identify Significant Gaps in Current Indirect Effect Analyses	July 2010
Task 4	Identify Available Data Sets and Models for Indirect Effects as a Function of Fuel Type	September 2010
Task 5	Develop a Long-Term <u>Work Plan*</u> for the ARB	October 2010

\* The long-term work plan will not contain numbers.



## Other Non-GHG Indirect Effects

- **Surface water quality**
  - increased use of fertilizers
  - erosion from cultivation
- **Ground water quality**
  - proppants from hydraulic fracking
  - spills
- **Water supply**
  - increased need for more irrigation
  - increased need for oil sands extraction
- **Food vs. fuel**
  - increased cost of food
  - decreased supply
- **Ecological effects**
  - loss of habitat due to deforestation
  - increase risk of fires
- **Protection of oil supply**



## Additional Studies

- CARB Expert Workgroup report – end of 2010
- European Union report – end of 2010
- National Science Foundation report – 2012



## Next Steps

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## Proposed Program Timeline

- Dec 2010 – draft rules
- 2011 - rule adoption
- 2012 – reporting year
- 2013 – first full year of compliance
- 2015 – program sunset date

If the legislature lifts the sunset date, then

- 2016 - full program review
- 2022 – last year of compliance

\* DEQ can review the program at any time if there are significant advances that will impact the methodology in estimating indirect effects